DEC STD 176-5 Printed-Wiring Board Acceptance Criteria for All Copper Product

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ABSTRACT: This standard specifies end product criteria for all copper rigid printed-wiring boards (PWBs) that have been fabricated or purchased by Digital Equipment Corporation.

APPLICABILITY: It is mandatory that, whether fabricated in Digital manufacturing facilities or purchased from qualified suppliers, all PWBs meet or exceed all applicable specifications defined in this standard, unless modified by applicable Digital engineering drawings and specifications.

STATUS: APPROVED 01-Dec-1992; use VTX SMC for current status.

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CONTENTS

1 INTRODUCTION 1
1.1 SCOPE 1
1.2 RESPONSIBILITIES 1
1.2.1 Digital Organizations 1
1.2.2 Suppliers 1
1.2.3 PWB Standards Committee 1

2 GENERAL REQUIREMENTS 2
2.1 TERMINOLOGY 2
2.2 COMPOSITION AND PROCESSING 2
2.3 MICROSECTIONING AND MAGNIFICATION 2
2.4 ROUNDING CONVENTION 2
2.5 FABRICATION MATERIALS 2
2.5.1 Soldermask 2
2.5.2 Plating Materials 3
2.5.3 Copper Finish Coating 3
2.6 WORKMANSHIP AND CLEANLINESS 3
2.7 IDENTIFICATION MARKINGS 4
2.8 COLORS 4

3 PLATED-THROUGH HOLES 4
3.1 PLATED HOLE DIAMETERS 4
3.2 PLATING THICKNESSES 4
3.3 OTHER PTHs CHARACTERISTICS 4

4 CONDUCTORS AND PADS 5
4.1 PLATING THICKNESSES 5
4.2 ADHESION 5
4.3 SOLDERABILITY 5
4.4 ANTIOXIDANT COMPLEXING AGENT 5

5 SOLDERMASK 5
5.1 PLACEMENT 6
5.1.1 Board Side 6
5.2 FLAMMABILITY 6
5.3 SOLDER RESISTANCE 6

6 ALLOWABLE REPAIRS 6

7 PRODUCT SAFETY 6

8 PACKAGING 6

9 ELECTRICAL CHARACTERISTICS 7

Appendix A REFERENCED DOCUMENTS 9

A.1 Digital Documents, EL-Class 9

A.2 Digital Documents, Other Than EL-Class 9
A.3 Federal and Military Publications 9
A.4 IPC (Institute of Printed Circuits) Publications 9

Appendix B RELATED DOCUMENTS 11
B.1 Digital Documents, EL-Class 11

Appendix C TESTING PROCEDURE FOR ANTIOXIDANT COPPER CHELATING AGENT 13
C.1 TESTING SCOPE 13
C.1.1 Equipment Required 13
C.1.2 Test Procedure 13

INDEX

TABLES
1 Magnification 2

1 INTRODUCTION

This standard specifies end product criteria for All Copper rigid printed-wiring boards (PWBs) that have been fabricated or purchased by Digital Equipment Corporation.

1.1 SCOPE

This standard specifies the final end product acceptance criteria for All Copper rigid printed-wiring boards of the types and technology codes specified in *DEC STD 176-0 Printed-Wiring Board Acceptance Criteria*, Table 1. This standard is intended to augment information presented in DEC STD 176-0 where final end product criteria for All Copper differs from conventional plated tin-lead/reflowed printed-wiring boards. This standard does not apply to flex circuits,ceramic printed-wiring substrates, press-pin backplanes, backplanes with solder connector contact pads (Burndy Connectors), or product with press-fit or staking pins.

An all copper PWB is a Solder Mask Over Bare Copper (SMOBC) board that has been cleaned and subjected to an antioxidant copper chelating agent rather then to tin/lead (Sn/Pb) plating or Hot Air Solder Leveling (HASL).

On all copper boards there is no Sn/Pb either under the solder mask or on the exposed areas. The exposed areas are seen as pink/copper, which are protected by invisible antioxidant complex.

1.2 RESPONSIBILITIES

This section describes specific responsibilities of persons or organizations for fulfilling the requirements of this standard.

1.2.1 Digital Organizations

All internal organizations involved in the fabrication, procurement, and use of PWBs are responsible for understanding and complying to the requirements in this document and for providing information to keep the document up-to-date.

1.2.2 Suppliers

Suppliers under contract to produce PWBs for Digital must comply with the requirements of this standard.

1.2.3 PWB Standards Committee

Refer to the applicable section of EL-SM176-00 *Printed-Wiring Board Manual*, for a list of committee members.

2 GENERAL REQUIREMENTS

Whether fabricated in Digital manufacturing facilities or purchased from qualified suppliers, all PWBs shall meet or exceed all applicable specifications defined in this standard, as modified only by applicable Digital drawings and specifications.

2.1 TERMINOLOGY

The definitions of all printed-wiring terms used in this standard shall be as specified in *DEC STD 016-0 Printed-Wiring Board and Module Manufacturing Terminology*.

2.2 COMPOSITION AND PROCESSING

The composition and processing of the types of PWBs covered by this standard shall be as described in DEC STD 016-0.

2.3 MICROSECTIONING AND MAGNIFICATION

Microsection inspections shall be performed in accordance with the latest revision of IPC-TM-650, *Test Methods Manual*. The appropriate minimum magnification is specified in Table 1. Higher magnification may be used to verify conformance to this standard's visual and functional requirements. Defects found at higher magnification are considered defects.

Table 1: Magnification

Item(s) Inspected	Minimum Magnification (X)
Overall cosmetic quality	Visual inspection
Board features	2
Referee inspection of board features	10
Plating quality in microsections	200
Plating and soldermask thickness in microsections	400

2.4 ROUNDING CONVENTION

See DEC STD 176-0, subhead 2.5.

2.5 FABRICATION MATERIALS

Fabrication materials are specified in DEC STD 176-0. For informational purposes, the following material requirements for soldermask and plating materials are provided.

2.5.1 Soldermask

The soldermask shall be a permanent polymer coating or photopolymer film that will prevent solder bridging during component assembly operations. Soldermask shall:

a. Conform to the latest revisions of IPC-SM-840, *Qualification and Performance of Permanent Polymer Coating (Soldermask) for Class II Printed-Wiring Boards*

b. Be recognized by Underwriters Laboratories (UL) according to *DEC STD 176-2 Printed-Wiring Board Product Safety Criteria*

c. Conform to the requirements of heading 5 of this standard

d. Conform to EL-MF543-00, *Procedure for Solder Mask Evaluation*

2.5.2 Plating Materials

The following plating materials, or approved functional equivalents, are acceptable for Digital PWBs. Plating thicknesses are specified in the text under subheads 3.2 and 4.1 of this standard.

a. Electroless copper—A suitable electroless (chemical) copper deposition material adherent to plastic and copper must be utilized in a preliminary process that provides a conductive layer over nonconductive base materials, prior to the electroplating of plated-through holes (PTHs).

b. Electrolytic copper—All electrolytically deposited copper plating shall conform to MIL-C-14550, *Copper Plating, Electrodeposited, Class 1*, and have a minimum purity of 99.5% as determined by ASTM E53-48, *Standard Method for Chemical Analysis of Copper (Electrolytic Determination)*.

c. Electrolytic nickel—All electrolytically deposited nickel plating shall be low stress and conform to Federal Specification QQ-N-290, *Nickel Plating, Electrodeposited, Class 2*.

d. Electrolytic gold—Gold electroplating shall conform to MIL-G-45204, *Gold Plating, Electrodeposited, Type II, Grade C*. The electroplating must also be uniform in quality and have a purity of 99%.

2.5.3 Copper Finish Coating

Copper finish coating is an antioxidant complexing agent used to prevent tarnish and oxidizing of copper surface after electroless and electrolytic copper plating. To determine presence of coating on All Copper PWB products, refer to Appendix C for the recommended test method.

All copper finish coatings shall be in accordance with the latest revision of Digital purchasing specification according to A-PS-1400031-GS, *Copper Chelating Material (Coating) All Copper*.

2.6 WORKMANSHIP AND CLEANLINESS

There shall be no contaminations or imperfections that affect form, fit, function, reliability, serviceability, or processability within a module application.

Ionic (electrical) contaminants shall not exceed the amounts specified in DEC STD 176-0, subhead 2.7.

Oxidation or contamination of the copper surfaces under the antioxidant coating, such as *water spots* or other types of discoloration, are not allowed on All Copper products.

If discoloration is evident, a representative sample shall be tested to determine if the discoloration is rejectable.

Discolorations in the antioxidant coating or on the coating surface, as evidenced by removal with a cotton swab containing isopropyl alcohol, are allowed providing ionic contamination and solderability requirements are maintained.

If the discoloration is not removed when wiped with a cotton swab containing isopropyl alcohol, the board is rejectable.

2.7 IDENTIFICATION MARKINGS

Digital and supplier PWB identification marking requirements are specified in DEC STD 176-0 with the following requirements for All Copper products. During the application process for the antioxidant coating, the test stamps may be removed; this is allowed as long as hard copy reports of all electrical tests are supplied with each lot.

2.8 COLORS

All PWBs shall be fabricated in the colors normally produced by processing the fabrication materials specified in DEC STD 176-0, and in the text under subhead 2.4 of this standard.

Regardless of the colors used and the degree of discoloration, the manufacturer's name or trademark and the Digital part identifier (part number and revision) must be legible.

3 PLATED-THROUGH HOLES

Requirements are specified in the following subheads for plated-through hole (PTH) diameters and plating thicknesses.

3.1 PLATED HOLE DIAMETERS

For nonsurface mount products, PTH diameters and tolerances must conform to DEC STD 176-0, Table 8. For surface mount products, PTH diameters and tolerances must conform to *DEC STD 176-4 Surface Mount Printed-Wiring Board Acceptance Criteria*.

To minimize scratching of copper antioxidant coating, it is recommended that:

- Supplier shall perform pin gauge operation prior to coating board with antioxidant agent.
- After coating, a pin gauge with a rounded end should be used (chamfer).

3.2 PLATING THICKNESSES

Copper plating thickness for nonsurface mount products must conform to DEC STD 176-0. Copper plating thickness for surface mount products must conform to DEC STD 176-4.

3.3 OTHER PTHs CHARACTERISTICS

PTH quality and reliability characteristics for All Copper products must conform to DEC STD 176-0.

4 CONDUCTORS AND PADS

Requirements for conductor widths and spacings, pad diameters, annular rings, edge characteristics and other characteristics are specified in DEC STD 176-0.

Exposed copper is acceptable on All Copper products, according to the requirements stated in DEC STD 176-0, subhead 9.9.4.

4.1 PLATING THICKNESSES

Requirements for electroless copper and electrolytic copper are specified in DEC STD 176-0.

4.2 ADHESION

When PWBs are inspected for plating adhesion using the tape test described in the latest revision of IPC-TM-650, no parts of the conductive pattern, including outgrowth, shall be removed from the boards. This test should be performed before the application of antioxidant coating.

4.3 SOLDERABILITY

Holes and terminal areas that will be soldered shall demonstrate at least 95% wetting with 5% unconcentrated dewetting and pinholing allowed. There shall be no dewetting, pinholing, or any solderability related defects allowed for surface mount pads. All nonterminal areas of surface power/ground planes and large etch widths not covered with soldermask may be dewetted.

Solderability tests shall be in accordance with IPC-S-804, *Solderability Test Methods for Printed-Wiring Boards*. Regardless of the test method used, the following shall occur.

a. Proper wetting of the surface, hole wall, and terminal area

b. No blistering, delamination (lifted conductors) or other forms of degradation of the conductive pattern

4.4 ANTIOXIDANT COMPLEXING AGENT

All unmasked (exposed) copper surfaces must be coated with complexing agent as evidenced by nitric acid test according to Appendix C.

5 SOLDERMASK

Soldermask shall cover conductors to prevent bridging during the module solder process.

Soldermask types, placement, thickness, cure, solvent/flux resistance, flammability, abrasion resistance, adhesion, soldering requirements, and other characteristics are specified in DEC STD 176-0, and modified for All Copper (where applicable) in the following subheads.

5.1 PLACEMENT

Soldermask placement and spacing requirements are specified in the following subheads.

5.1.1 Board Side

All Copper boards require full soldermask on both sides.

5.2 FLAMMABILITY

The soldermask material must meet all safety regulatory agency requirements as specified in DEC STD 176-2.

For solder resistance determination on nonsurface mount products, refer to DEC STD 176-0 . For solder resistance on surface mount products, refer to DEC STD 176-4.

5.3 SOLDER RESISTANCE

The soldermask material must meet all safety regulatory agency requirements as specified in DEC STD 176-2.

For solder resistance determination on nonsurface mount products, refer to DEC STD 176-0 . For solder resistance on surface mount products, refer to DEC STD 176-4.

6 ALLOWABLE REPAIRS

Digital and non-Digital Equipment Corporation supplier personnel may perform repairs as specified in *DEC STD 176-1 Printed-Wiring Board Repair Criteria*. After repair, the board must meet all physical, electrical, cosmetic, workmanship, and cleanliness requirements of this document and DEC STD 176-0.

Repairs on All Copper products shall be performed prior to coating with antioxidant agent. Should repair be required after coating is applied, the entire board must be recoated after repair is complete.

7 PRODUCT SAFETY

All product safety and UL requirements for all printed-wiring boards supplied to or made by Digital are specified in DEC STD 176-2.

8 PACKAGING

In addition to good commercial practice in packaging, marking, shipping, and storing, packaging requirements shall be as specified in DEC STD 176-0, with the following additional requirement for All Copper products. Packaging material shall not damage or discolor the antioxidant finish.

In any one package, each board must be separated from adjacent boards by suitable packaging or wrapping material that extends to all edges of each board.

Each container of boards must include an indicating desiccant material.

9 ELECTRICAL CHARACTERISTICS

Electrical characteristic requirements for All Copper products is specified in DEC STD 176-0 with the following addition: all electrical testing shall be performed prior to application of antioxidant agent.

APPENDIX A REFERENCED DOCUMENTS

A.1 Digital Documents, EL-Class

Document Number	Document Title
EL-00016-00	*DEC STD 016-0 Printed-Wiring Board and Module Manufacturing Terminology*
EL-00176-00	*DEC STD 176-0 Printed-Wiring Board Acceptance Criteria*
EL-00176-01	*DEC STD 176-1 Printed-Wiring Board Repair Criteria*
EL-00176-02	*DEC STD 176-2 Printed-Wiring Board Product Safety Criteria*
EL-00176-04	*DEC STD 176-4 Surface Mount Printed-Wiring Board Acceptance Criteria*
EL-MF543-00	*Procedure for Soldermask Evaluation*
EL-SM176-00	*Printed-Wiring Board Manual*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

A.2 Digital Documents, Other Than EL-Class

Document Number	Document Title
A-PS-1400031-GS	*Copper Chelating Material (Coating) All Copper*

A.3 Federal and Military Publications

EL-Class Number	Document Title
QQ-N-290	*Nickel Plating, Electrodeposited, Class 2*
MIL-C-14550	*Copper Plating, Electrodeposited, Class 1*
MIL-G-45204	*Gold Plating, Electrodeposited, Type II, Grade C*
ASTM E53-48	*Standard Method for Chemical Analysis of Copper (Electrolytic Determination)*

Copies of these federal and military publications may be obtained free of charge from the Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120, USA, telephone (215) 697-3321.

A.4 IPC (Institute of Printed Circuits) Publications

EL-Class Number	Document Title
IPC-SM-840	*Qualification and Performance of Permanent Polymer Coating (Soldermask) for Class II Printed-Wiring Boards*
IPC-S-804	*Solderability Test Methods for Printed-Wiring Boards*

EL-Class Number	Document Title
IPC-TM-650	*Test Methods Manual*

Copies of these IPC publications may be purchased from the Institute for Interconnecting and Packaging Electronic Circuits, 7380 North Lincoln Ave., Lincolnwood IL 60646, Telephone (708) 677-2850.

APPENDIX B RELATED DOCUMENTS

B.1 Digital Documents, EL-Class

Document Number	Document Title
76-65075-00	*Procedure for Processing Non-Conforming Material and In-Process Waiver*
EL-MF299-00	*Printed-Circuit Boards/Modules: Cleaning Process Contamination*
EL-MF733-00	*All Copper Implementation Plan (A Template for Technology Implementation)*

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APPENDIX C TESTING PROCEDURE FOR ANTIOXIDANT COPPER CHELATING AGENT

C.1 TESTING SCOPE

This procedure should be used to determine the presence of an antioxidant chelating complex on an all copper PWB.

C.1.1 Equipment Required

1. Fresh solution of 10% nitric acid with deionized water
2. Eye dropper
3. 5X glass
4. Two cotton swabs
5. Safety glasses with side shields
6. Rubber gloves (nonparticulate)
7. Watch or clock
8. Bottle of isopropyl alcohol

C.1.2 Test Procedure

1. Put gloves and safety glasses on.
2. Locate copper area on PWB.

First choice	thieving area
Second choice	any nonsoldermask copper area (ground planes)
Third choice	any SMT pad area
Fourth choice	any PTH pad area

3. Ensure that the nitric acid and deionized water solution is mixed (gently shake the container).
4. Hold the eye dropper close to the copper surface and place a drop of the solution onto the selected copper area.

NOTE

Ensure that in the process, air bubbles are not trapped under the nitric acid drop as this could be confused with actual bubbling caused by the reaction between the nitric acid and copper.

5. After 60 seconds, examine the area under the drop with the 5X glass for evidence of bubbles.
   a. If there are no bubbles, the PWB has been properly coated with the antioxidant complex and is to be accepted.
   b. If there is evidence of bubbling, the PWB lacks adequate antioxidant protection and is to be rejected.
6. After testing, use a clean dry cotton swab to blot up all testing solution.
7. Wet a second cotton swab with isopropyl alcohol and clean the test area. If a pad with a hole was used as a test site, ensure that the isopropyl alcohol wetted the hole walls.
8. Allow the PWB to air dry.

INDEX

A

Adhesion, 5

C

Cleanliness
  Workmanship, 3
Colors, 4
Composition and processing, 2
Conductors, 5

F

Fabrication materials, 2

M

Magnification, 2
Markings
  Identification, 4
Microsectioning, 2

P

Packaging, 6
Pads, 5
Plated hole diameters, 4
Plated-through holes, 4
Plating
  Materials, 3
  Thicknesses, 4
Product safety, 6
PWB Standards Committee, 1

R

Repairs, 6

S

Solderability, 5
Soldermask, 2, 5, 6
Solder resistance, 6
Suppliers, 1, 2

T

Terminology, 2

U

UL requirements, 6

W

Workmanship
  Cleanliness, 3

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